

Sediment and Water Quality in Massachusetts Coastal and Marine Ecosystems

Is it safe to swim, fish, and recreate
and what do we mean by "clean" or
"dirty"?

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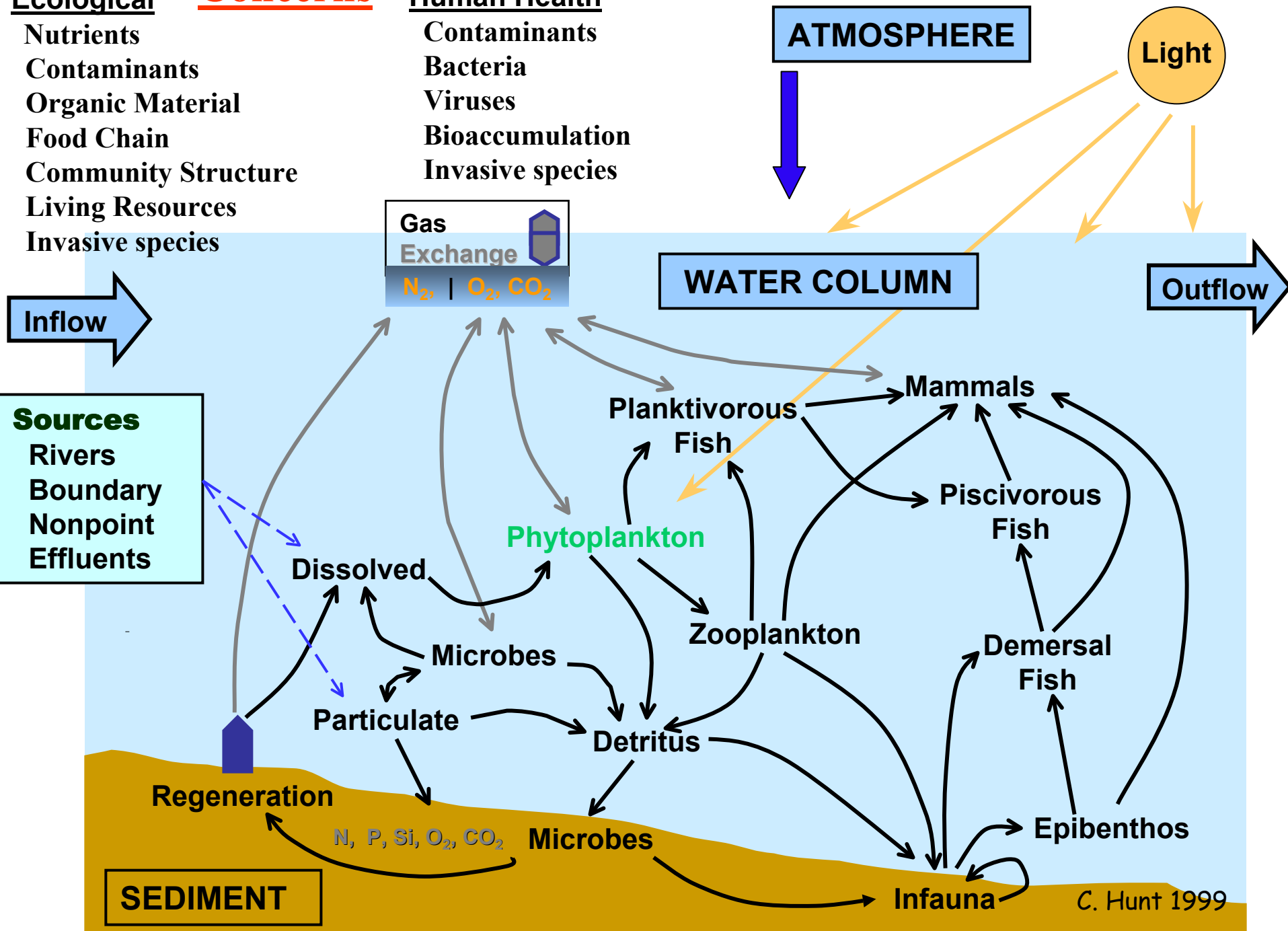
"Love that dirty water - Boston you're my town"
but it is not just Boston...

- Will cover:
 - General categories of pollutants in water and sediment
 - Discuss impacts to humans and ecosystem
 - Identify what we know and don't know
- Pollution is related to population size - through land-based activities and other human impacts
- Pollution impacts are greater near shore compared to off shore
- Offshore parallels near shore, but is largely unseen

Ecological

- Nutrients
- Contaminants
- Organic Material
- Food Chain
- Community Structure
- Living Resources
- Invasive species

Contaminants
Bacteria
Viruses
Bioaccumulation
Invasive species



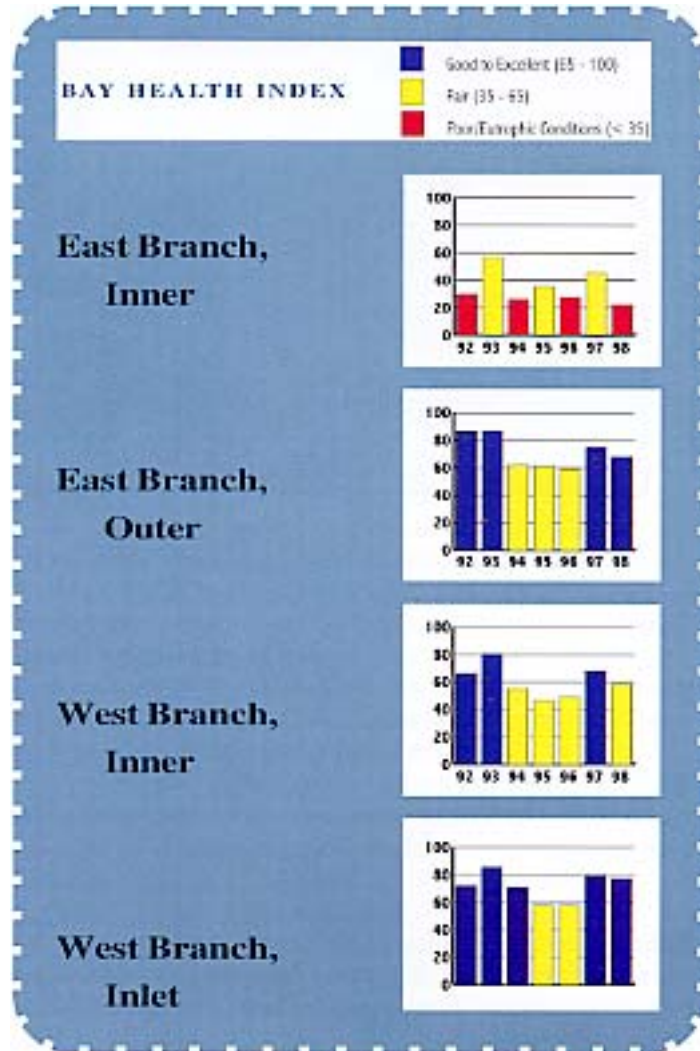
Bacteria, viruses and other disease causing organisms

- Standards are international (shellfish) national (drinking water, swimming stds), and local communities -offers a level of protection but...
- In areas with high levels of pollution and contamination, clams may become leukemic (C. Reinish studies in Boston Harbor) seals may get distemper (in the UK in the early 1990s)
- State wide we are seeing increasing closures of beaches but we are not necessarily addressing the problem - e.g. CSOs in South Boston and Fort Point Channel

Nutrients include organic materials (e.g. dead parts of plankton) and land-based discharges of nitrogen, carbon, phosphorus, and other wastes and dissolved oxygen

- Excessive nutrients cause accelerated eutrophication of near shore areas - the most productive marine ecosystems
- Greatest impact in embayments - can measure as dissolved oxygen - but by then the system is in serious decline
- Major concern for the MWRA outfall monitoring program - relationship to plankton and marine mammals
- Eutrophication is largely irreversible - e.g. 15 years for groundwater to reach coastal areas, even if ALL were stopped, effect could grow for next 15 years.

Water pollution index in the East and West Westport River, Buzzards Bay, Ma



Buzzards Bay Coalition 1999

Overall picture of water quality in Buzzards Bay

Nitrogen Management Concerns	Aquamagnum Bay	Eel Pond, Manapomet	Aquamagnum River	Weston River	Westport River	Acushnet River, East Branch	Stoughton River	Little River	Herring River	New Bedford Cove	Barnstable Harbor	Little Neck River	Red Bank, Mashpee	Acushnet Harbor	Sperdy Cove	Broad Marsh Harbor	Nashua River	Sperdy Bay	Black River	Eel Pond, Bourne	Hens Cove	Shell Point Bay	Westport River, West Branch	Oyster Bay	Charles Cove	Pocasset River	Pocasset Harbor	Barnstable Bay	Manapomet Harbor	Mashpee Harbor	Priney's Harbor	Quincy Harbor
Nitrogen loading from septic systems associated with existing development	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●								
Residential development of open space & associated nitrogen loading at buildout	●	●	●	●	●	●		●		●	●	●	●	●	●	●	●			●	●	●	●	●	●		●	●	●	●	●	
Nitrogen removal capacity of municipal Waste Water Treatment Facility (Sewage)			●		●				●	●		●	●		●	●						●										
Nitrogen loading from agricultural fertilizer applications (e.g. cranberry bogs, croplands)			●	●	●	●	●			●	●	●	●			●						●										
Nitrogen loading from turf fertilizer applications (e.g. residential lawns, golf course)		●						●									●			●			●	●				●			●	
Runoff from animal waste	●				●						●					●																
Contaminated groundwater discharge from Solid Waste Landfill plume						○	○				○		●	●									●			●			●	○		
Nitrogen imported from outside watershed			●	●	●	●	●		●	●			●	●	●							●				●						
Combined Sewer Overflow (CSO) discharges					●				●															●								

 \otimes = Level of consumer involvement.

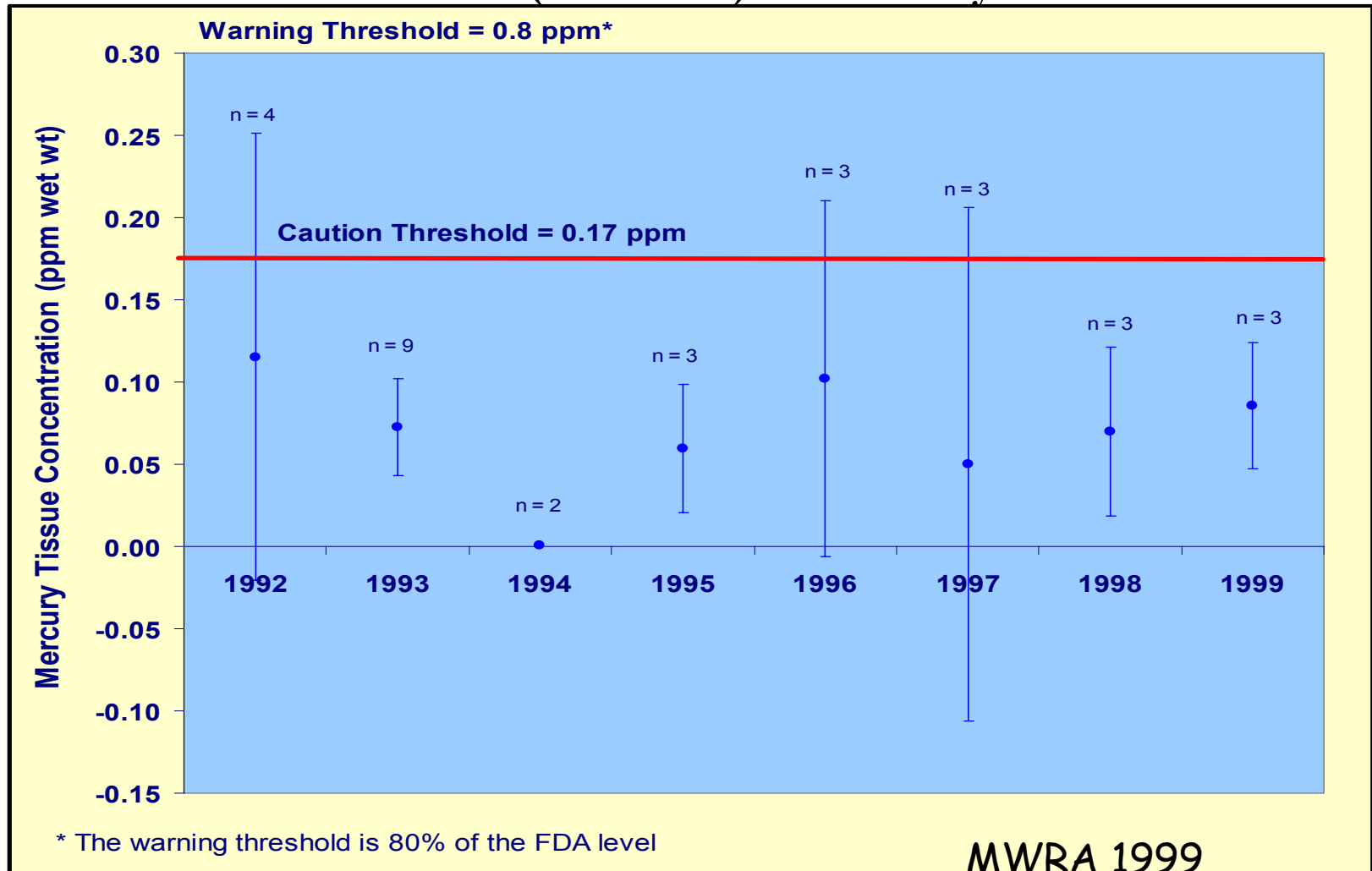
Notes: Other common pollution sources to coastal waters such as residential road runoff and boat wastes, while important to manage to reduce bacterial and other contamination, are typically considered minor nitrogen sources and therefore not included in this matrix.

Metals are elements, do not break down, and in excess a problem

- About 12-15 "heavy metals" are considered problematic to humans and ecosystem, but levels of toxicity varies with metals
- "free ion" is the toxic form but concentrations do not tell whole story as metals may associate with particles
- Organisms may have biochemical means of sequestering excessive metal contamination in shells, proteins etc.
- Accumulate in sediments, do not break down, and are signature of past activities
- Highest in regions of industrial use, urban harbors, CCA treated woods, run off etc.
- Two issues create difficulty in regulations
 - Cause and effect is poorly documented in the field
 - Different agencies use different risk assessments but
- Locally, organisms affected by metals-algae, molluscs show imposex, etc.

Flounder Hg Threshold Comparisons

Annual Means ($\pm 95\%$ CI) at Mass Bay Outfall

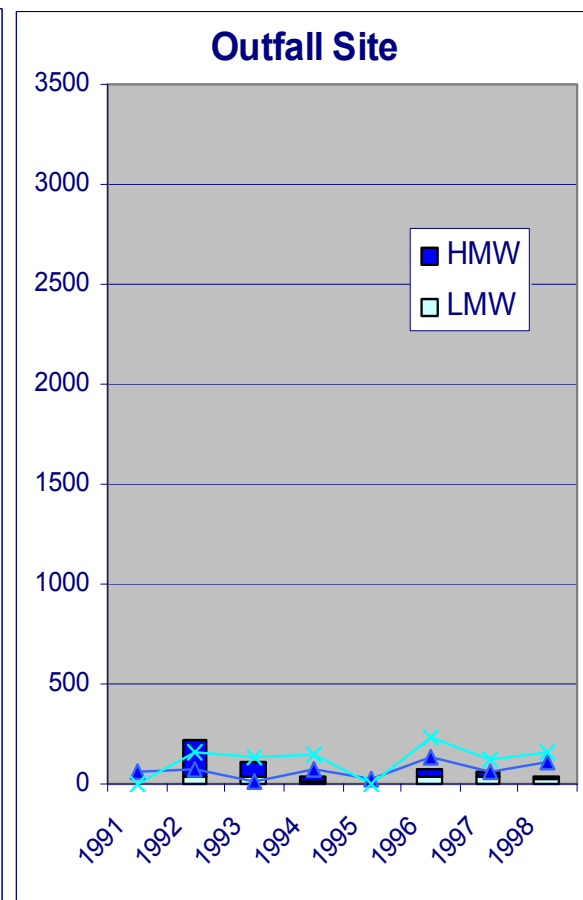
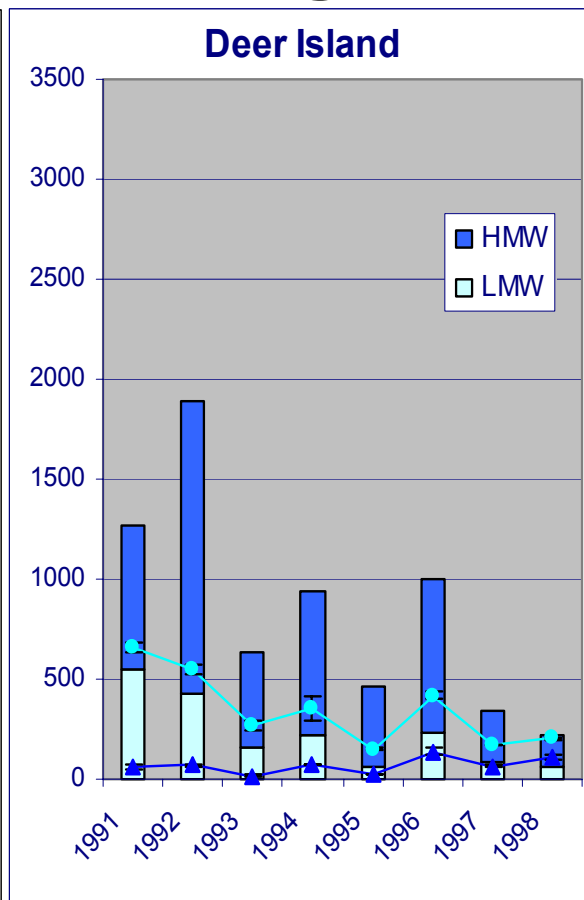
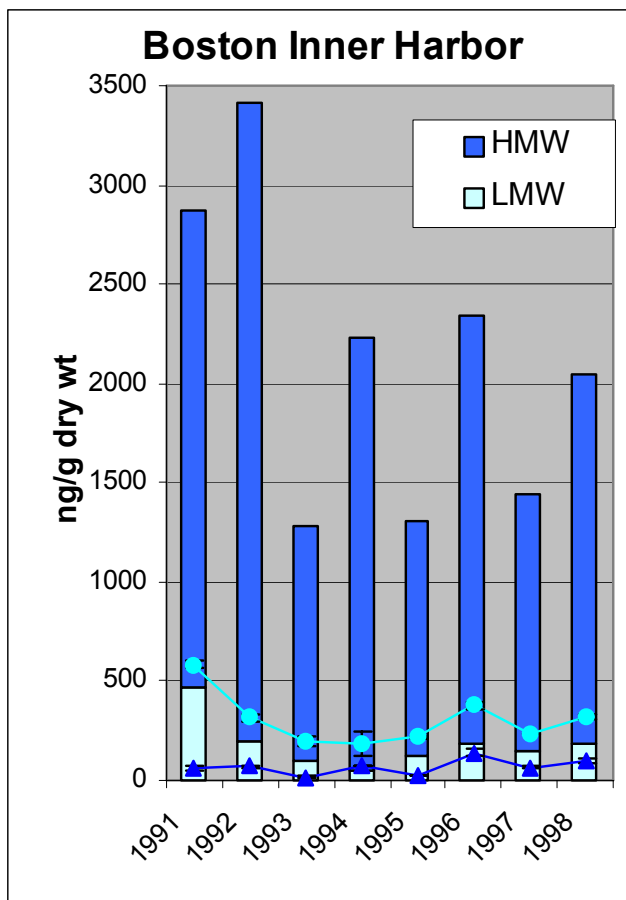


Organic chemical compounds are often called persistent organic pollutants and are carcinogenic, mutagenic and teratogenic

- Bad actors are PAH, PCB, petroleum hydrocarbons, pesticides, organo-metal complexes, creosote, endocrine disrupters, some from combustion of fossil fuels
- MANY, many chemicals, e.g. PCB has 209 forms, 16 are considered toxic
- Chemicals accumulate in tissues; enzymes break down and some organisms excrete
- Associated with tumors in fish, decreased immunity,
- May cause mortality (e.g. PAH, petroleum), accumulate (high molecular weight PAH, PCB, dioxin, etc.
- Two toxic organo-metals are tributyl tin (used in antifouling paints) and organo-mercury (methylmercury is found in fish tissues)
- **VERY** small amounts create problems to humans and ecosystems, but again cause and effect relationships in the field are difficult to demonstrate

Mussels PAH

Low and High Molecular Weight



Predeployment LMW Concentration

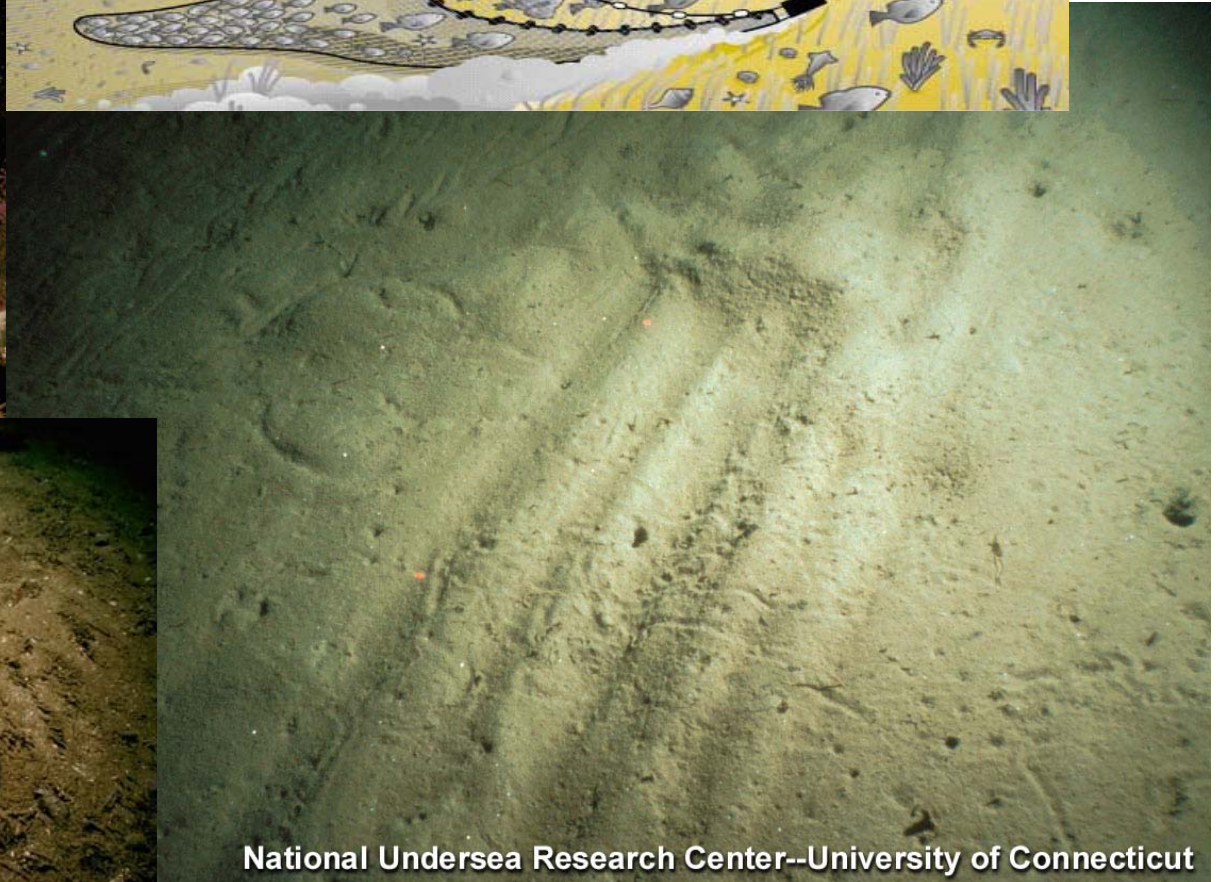
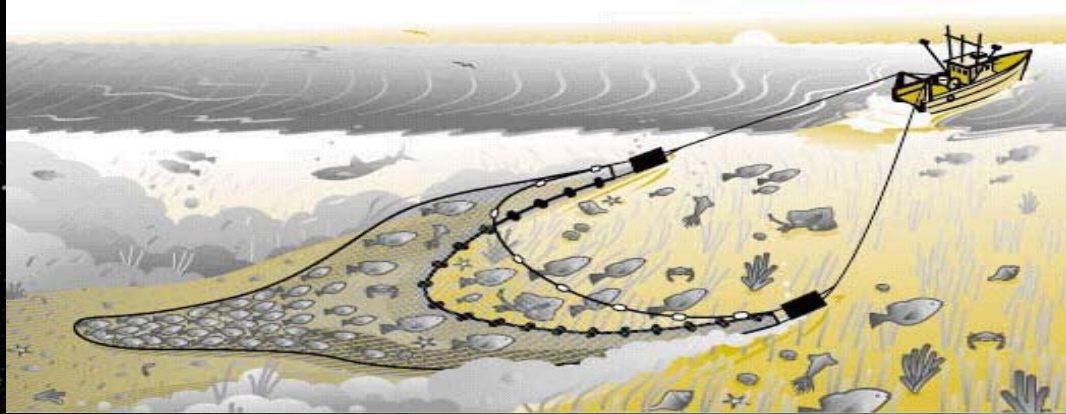
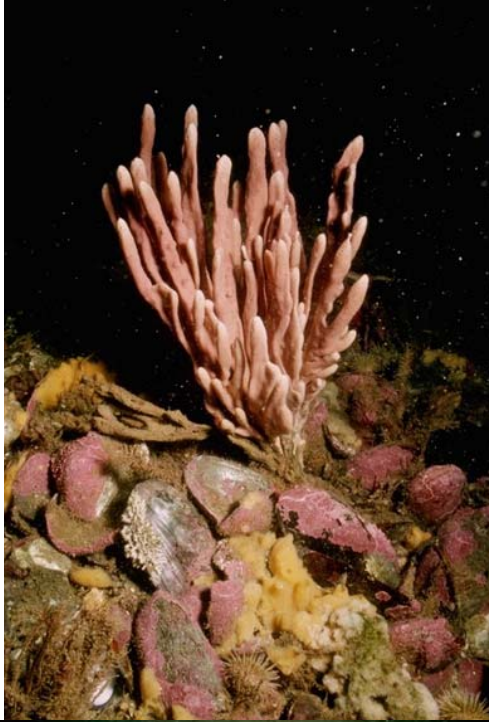
Predeployment HMW Concentration

M. Hall 1999

Sediments smother organisms, alter flow, transport contaminants

- Coastal development and poor land management
- Trawling, dredging, hydro-dredging, etc. resuspend sediments
- Armoring of coast interferes with sediment transport
- Changes substrate, compacts sediments and eliminates heterogeneity - even in sandy soils
- **This is both a near shore and off shore threat to our ecosystem resources**

Fishing gear effects on the sea floor



Invasive species - biopollution that reproduces and spreads

- In some areas of San Francisco Bay 99% of biomass and 95% of species are introduced
- In Massachusetts between 25-50% of species identified in fouling communities are introduced and cryptogenic
- Once introduced species arrive, they are not likely to be eradicated
- We need to prevent species from arriving
- Regional approach to a global problem



*L to R: Carcinus
maenas, Hemigrapsus
sanguineus, Codium
fragile, Styela clava,
Didemnum sp.*



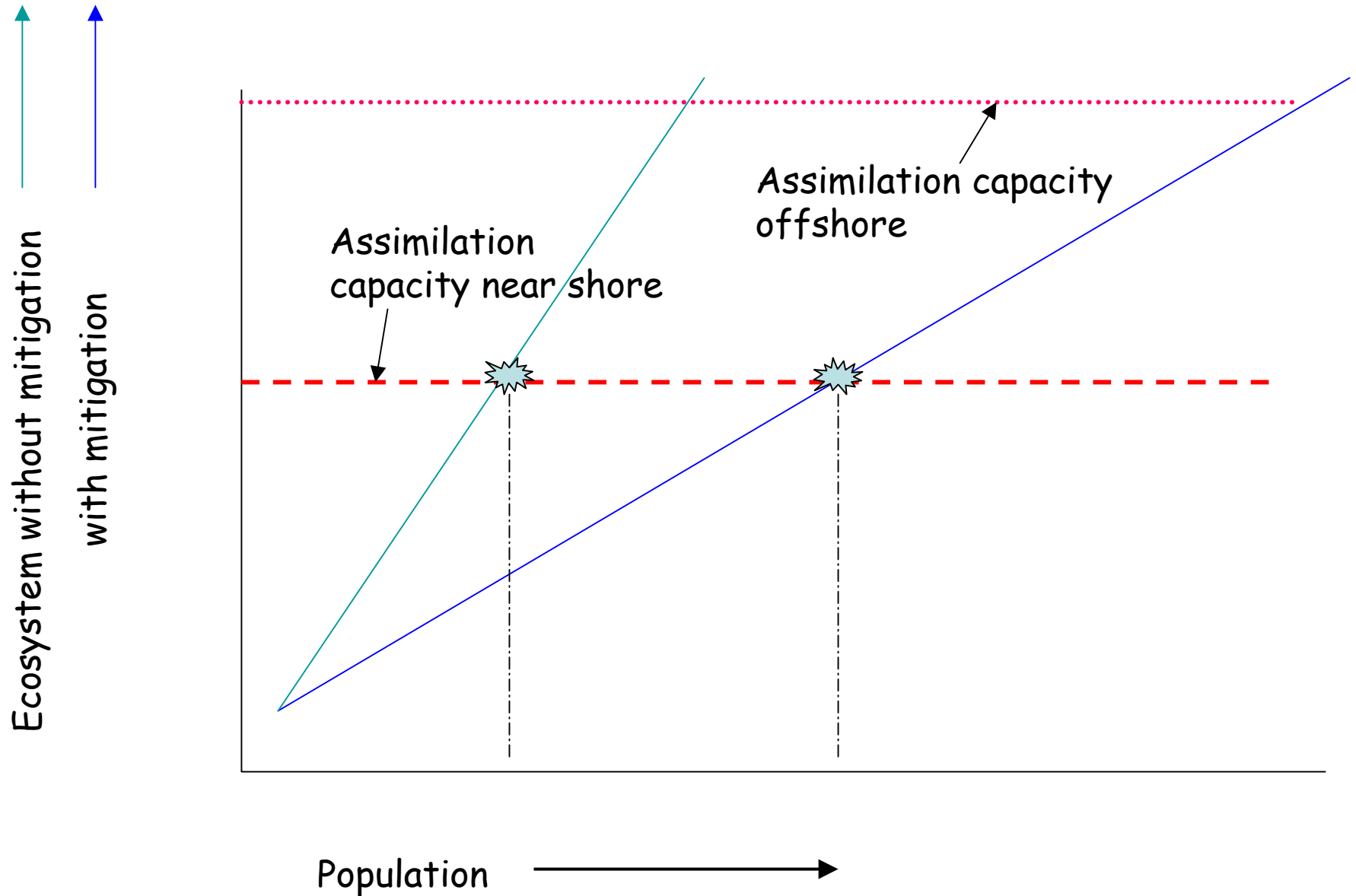
Non-native species in Massachusetts

Photos: P. Erickson, P. Dyrynda, E. Ford, J. Pederson,
McNair

General categories of pollutants and impacts

Pollutant	Human impact	Ecosystem impact	Level of impact
Bacteria, viruses, et al.	Yes, monitor indicator	Qualified no	Can be high locally near shore
Nutrients, organic carbon, dissolved oxygen	Contributor, related to population	In excess, yes	High and rarely reversible
Particles and sediments	Contributor, development and poor land use practices	Locally yes, impacts larger area	High and rarely reversible
Metals	Minimal, with exceptions	Qualified yes and no	Where high major impact, long-lived
Organic chemical compounds	Potentially dangerous	Potentially dangerous	Potency and concentration, long-lived
Biopollution - invasive species	Yes and no, HABs, diseases,	Yes and growing as we learn more	Irreversible

Conceptual look at population impacts to ecosystems



Recommendations for future management

- Need better documentation of costs to environment and human health of pollutants/contaminants otherwise we are stalled in preventing misuse of our resources
- Need regional indicators to monitor health
- Need an ocean management policy for the greater good